ALIGNMENT OF MONTANA STATE STANDARDS WITH STATE ASSESSMENTS

James C. Leffler
Maureen Carr
Linda Griffin
Claire Gates

March 2005

Northwest Regional Educational Laboratory
101 SW Main Street, Suite 500
Portland, Oregon 97204

Table of Contents

List of Tables and Figures

A Study of the Alignment Between the Montana State Standards and the Spring 2005 CRT Instruments

Organization of This Report

Generally, this report can be divided into four sections, moving from general to specific.

The first section (beginning on this page) includes descriptions of the background, purpose, methodology, process, and the four specific criteria that are examined in the alignment model.

The second section (beginning on page 4) includes summary findings and conclusions for each of the four criteria.

The third section (beginning on page 7) includes more detailed information for each of the alignment criteria.

The fourth section (beginning on page 15) includes detailed data for each of the Montana state standards and objectives and for each of the test items/tasks.

Purpose

To study the alignment between the Montana State Standards and the Spring 2005 versions of the grades 4, 8 and 10 Mont-CAS CRT developed by Measured Progress.

Methodology

The process of examining the alignment used by NWREL to conduct this study is based primarily on the work of Norman Webb (1997, 1999, 2001, 2002, and 2004) as referenced in the *Peer Reviewer Guidance For Evaluating Evidence of Final Assessments Under Title I of the Elementary and Secondary Education Act* (US Department of Education, 1990, *Research Monograph No. 8, Criteria for Alignment of Expectations and Assessments in Mathematics and Science Education* (Webb, 1997), in *Research Monograph No 18, Alignment of Science and Mathematics Standards and Assessments in Four States* (Webb, 1999) as published by the National Institute for Science Education, University of Wisconsin-Madison and the Council of Chief State School Officers, and *Standards and Assessments Peer Review Guidance: Information and Examples for Meeting Requirements of the No Child Left Behind Act of 2001* (US Department of Education, 2004). *State Standards and State Assessment Systems: A Guide to Alignment* (2000) by La Marca, Redfield and Winter, also published by the Council of Chief State School Officers was also used for reference.

The Webb model examines the degree of intersection between the state standards and the state assessments. The model examines the intersection along four axis: 1) categorical

concurrence, 2) depth of knowledge consistency, 3) range of knowledge correspondence, and 4) balance of representation.

Webb Alignment Model Criteria

Alignment Criterion #1– Categorical Concurrence:
(Webb 1999, page 7) states, "The criterion of categorical concurrence between standards and assessment is met if the same or consistent categories of content appear in both …." State standards and assessments. The criterion is judged by examining both the assessments and the standards to determine whether in fact the assessment instruments do in fact include items that measure the content of the standards.

(Webb 1999) assumes that if an assessment instrument contains at least six items measuring the content of a standard, that assessment has attained 'acceptable' categorical concurrence. Six is considered to be the minimum for an assessment to be considered 'acceptable." For further discussion of Webb's rationale on this matter, please refer to page 7 of Webb's *Research Monograph No. 18 – Alignment of Science and Mathematics Standards and Assessments in Four States*, published by the National Institute for Science Education and the Council of Chief State School Officers in 1999.

Alignment Criterion #2 – Depth-of-Knowledge Consistency:
"Depth-of-Knowledge consistency between standards and assessment indicates alignment if what is elicited from students on the assessment is as demanding cognitively as what students are expected to know and do as stated in the standards." (Webb, 1999, page 7) This alignment examines the alignment not only between contents of standards and assessments, but also the complexity of knowledge required by each.

Webb 1999 defines an 'acceptable' level of consistency being that "at least 50% of the items corresponding to an objective had to be 'at' or 'above' the level of knowledge of the objective" as a whole. Webb also defines a standard that has between 40% and 50% of its items at or above the depth-of-knowledge of the standard as a whole as having "weakly met" the criteria for Depth-of-Knowledge consistency.

Alignment Criterion #3 – Range-of-Knowledge Correspondence
The third criterion for alignment described by Webb is that of range-of-knowledge or breadth of knowledge. On page 8 of his 1999 monograph, Webb describes this as, "The range-of-knowledge criterion is used to judge whether a comparable span of knowledge expected of students by a standard is the same as, or corresponds to, the span of knowledge that students need in order to correctly answer the assessment items/activities. The criterion for correspondence between span of knowledge for a standard and the assessment considers the number of objectives within the standards with at least one related assessment item/activity."

To be 'acceptable' according to Webb's work, at least 50% of the objectives for a standard must have at least one related assessment item/activity.

Alignment Criterion #4 – Balance of Representation

Assessment instruments and standards need to be comparable not only in breadth of knowledge (categorical concurrence) and depth of knowledge (depth-of-knowledge consistency) but also in equal distribution of the knowledge. The criterion of Balance of Representation is used to indicate the extent to which assessment items are evenly distributed across objectives.

For purposes of this study, a less formal method of examining Balance of Representation is used.

Process Description

1. The alignment process was conducted for each area of criteria and for each content area by two to three professional staff with background in instruction, assessment, evaluation, and/or content area expertise. Ratings used in calculating alignment for each of the four criteria described above were determined through consensus. In the Webb model, ratings are determined by averaging the individual rater marks rather than by consensus.

2. NWREL staff examined Montana state standards and benchmark materials.

3. Through consensus, a depth-of-knowledge level was determined for each performance standard. That level represented the highest level of knowledge expected for that standard. For more detailed descriptions of Depth-of-Knowledge level definitions see Appendix B.

4. Raters then examined each assessment item/activity and marked it as a 'hit' for each correlating standard addressed by that item/activity. An individual assessment item/activity was allowed to 'hit' more than one standard. In the Webb model, items are only tabulated as a "hit" for one standard.

5. Raters determined the depth-of-knowledge level of each individual assessment item/activity. Item depth-of-knowledge level was then compared to the depth-of-knowledge level of the performance standard as a whole (as determined in step one above). Each item was then classified as being "at," "above," or 'below" the level of the performance standard as a whole.

6. The percentage of objectives within a standard, being assessed by one or more assessment item/activity was then calculated.

7. A balance-of-representation index was then calculated for each standard is displayed in a bar charts. The balance-of-representation examines the extent to which assessment items/activities are evenly distributed across the standards.

Summary of Findings and Conclusions

Categorical Concurrence – is each standard assessed by at least six items/tasks?

Reading:

- Montana has five standards in the area of reading.
- The fourth grade instrument meets the criteria for categorical concurrence in 60% of the standards, the eighth grade instrument meets the criteria in 80% of the standards, and the tenth grade instrument meets the criteria in 40% of the standards.
- None of the three grade level instruments meet the criteria for Reading Standard three – students set goals, monitor, and evaluate their progress in reading.
- Standard three, by its nature, is difficult to assess on a standardized instrument, such as that being used in Montana.
- Reading Standard three, at all three grade levels, should be examined to determine whether it would be appropriate to add items to the current instrument to assess it, or whether the standard would better be assessed through some other method such as classroom based assessment.
- Reading Standard four, at grade 10, only missed meeting the criteria by a single item/task. One additional item could be added if it was felt that was significant.
- Reading Standard five, at grade 10, currently has no items which assess it. That should be examined to determine whether items should be added or whether another assessment method might be more appropriate.

Mathematics:

- Montana has seven standards in the area of mathematics.
- The fourth, eighth and tenth grade instrument all meet the criteria for categorical concurrence in 85.7% of the standards.
- None of the grade level instruments adequately meet the categorical concurrence criteria for Mathematics Standard one – students engage in the mathematical process of problem solving and reasoning, estimation, communication, connections and applications, and using appropriate technology.
- Math standard one, by its nature, is difficult to assess on a standardized instrument.

Depth of Knowledge – are the test items/tasks written at a cognitive level at or above that of the state standard (50% at or above meets criteria, 40-50% weakly meets the criteria).

Reading:

- Of the Montana standards in reading, 80% are written at a Depth of Knowledge level 3 and 20% at a level 2. Level three is reasonable, and most likely desirable, as a standard, but is difficult to fully assess on a forced choice instrument.
- Depth of Knowledge is especially weak in the area of reading, most likely due in part to the overall higher Depth of Knowledge level of the state standards.

- For only one out of five standards at grades four and ten does the instrument meet the criteria for Depth of Knowledge.
- At grade four it is met at the "weak" level, while at grade ten it is at the "acceptable" level.
- With the grade eight instrument, Depth of Knowledge criteria is "acceptable" for one standard and "weakly met" for one additional standard.
- Grade 8 and 10 instruments and items should be examined. At grade 8 two of the five standards have no items "at or above" the level of the standard. At grade 10, three of the five standards have no items "at or above" the level of the standard

Mathematics:

- Generally, the Montana math standards are written at a lower Depth of Knowledge level than are the reading standards. This will have the effect of making it easier to meet the criteria for Depth of Knowledge.
- Of the Montana standards in mathematics, 76.2% are written at a Depth of Knowledge level 2 and 23.8% at level 3.
- Depth of Knowledge is especially weak in the tenth grade mathematics instrument. For only one out of seven standards (14.3%) at grade ten, does the instrument meet the criteria for Depth of Knowledge.
- At grades four and eight, the criteria is met at the "acceptable" level for three of seven areas (42.8%) in grade four and for five of seven areas (71.4%) in grade eight.
- The grade 8 instrument is the strongest with regard to Depth of Knowledge.
- The grade 10 instrument is the weakest with regard to Depth of Knowledge.

Range of Knowledge: Are at least half of the objectives for each standard assessed by at least one related assessment item/task?

Reading:

- Standard three – students set goals, monitor, and evaluate their progress in reading is not assessed by a single item in any of the three grade levels.
- At grade 10, there are no items to assess standard five. This should be examined.
- At grade 4, only one standard does not have at least one item/task for each objective.
- At grade 8, two standards do not have at least one item/task for each objective.
- At grade 10, three standards do not have at least one item/task for each objective.

Mathematics:

- In mathematics, the criteria are met for varying numbers of standards across the three grade level instruments, with 28.6% at grades eight and ten, and 57.1% at grade four.
- In all of the mathematics standards, there are no standards that are not at least partially assessed.
- Only at grade 10, standard one does not have at least one item/task for each objective.

Balance of Representation – Are assessment items/tasks evenly distributed across objectives?

Balance of Representation is not present in any of the grade level instruments in either reading or mathematics, though mathematics is more balanced than reading.

The Balance of Representation criteria assumes that all standards are of equal value and weight, which may in fact not be the case. It also assumes that all standards can be assessed equally well with the type of test instrument in use (essential forced-choice items with a few short response items in the case of Montana's instrument) which again in fact is not the case. Due to these two factors, it is not surprising that the Montana Spring 2005 instrument does not meet the criteria for Balance of Representation.

Reading:

- The preponderance of items in the reading instrument at all three grade levels are found in the first two standards (89% of the grade 4 items assess standards one and two, 77% of the items in grade 8, and 95% of the items at grade 10).
- No items in any of the three grade level instruments assess the third state standard.
- The remaining items (11% at grade 4, 23% at grade 8, and 5% at grade 10) assess standards four and five.
- The reading items are not balanced across the objectives within each standard. If Montana considers all objectives within each standard as equal, this should be examined more closely.
- The range in grade four is from 0 to 24 items per objective, in grade 8 is from 0 to 25 items per objective, and in grade 10 from 0 to 26 items per objective.

Mathematics:

- Standard one (and to a lesser degree, standard seven) are assessed by a much smaller number of items/tasks at all three grade levels.
- This is most strongly demonstrated at grade 10, where only a single item is used to assess standard one. At grade 4, four items assess standard one, and at grade 8, three items assess standard one.
- The pattern across other standards and other grade levels is less clear.
- The mathematics items are not balanced across the objectives within each standard. If Montana considers all objectives within each standard as equal, this should be examined more closely.
- The range in grade four is from 0 to 8 items per objective, in grade 8 from 0-6 items per objective, and at grade 10 from 0 to 12 items per objective.

Alignment Data – State Standards Level

Alignment Criterion #1– Categorical Concurrence:

The criterion of categorical concurrence between standards and assessment is met if the same or consistent categories of content appear in both. To meet the criteria, an assessment instrument must contain at least six items measuring the content of a standard.

Reading Grade 4	**# of Items**	**Meets Categorical Concurrence Criteria Y/N**
Standard 1	58	Y
Standard 2	57	Y
Standard 3	0	N
Standard 4	12	Y
Standard 5	3	N

Table 1.1 Fourth Grade Reading Categorical Concurrence

Reading Grade 8	**# of Items**	**Meets Categorical Concurrence Criteria Y/N**
Standard 1	50	Y
Standard 2	43	Y
Standard 3	0	N
Standard 4	8	Y
Standard 5	6	Y

Table 1.2 Eighth Grade Reading Categorical Concurrence

Reading Grade 10	**# of Items**	**Meets Categorical Concurrence Criteria Y/N**
Standard 1	37	Y
Standard 2	66	Y
Standard 3	0	N
Standard 4	5	N
Standard 5	0	N

Table 1.3 Tenth Grade Reading Categorical Concurrence

Mathematics Grade 4	# of Items	Meets Categorical Concurrence Criteria Y/N
Standard 1	4	N
Standard 2	18	Y
Standard 3	7	Y
Standard 4	10	Y
Standard 5	14	Y
Standard 6	6	Y
Standard 7	6	Y

Table 1.4 Fourth Grade Mathematics Categorical Concurrence

Mathematics Grade 8	# of Items	Meets Categorical Concurrence Criteria Y/N
Standard 1	3	N
Standard 2	14	Y
Standard 3	13	Y
Standard 4	15	Y
Standard 5	15	Y
Standard 6	13	Y
Standard 7	7	Y

Table 1.5 Eighth Grade Mathematics Categorical Concurrence

Mathematics Grade 10	# of Items	Meets Categorical Concurrence Criteria Y/N
Standard 1	1	N
Standard 2	12	Y
Standard 3	10	Y
Standard 4	11	Y
Standard 5	7	Y
Standard 6	10	Y
Standard 7	9	Y

Table 1.6 Tenth Grade Reading Categorical Concurrence

Alignment Criterion #2 – Depth-of-Knowledge Consistency:

Depth-of-Knowledge consistency between standards and assessment indicates alignment if what is elicited from students on the assessment is as demanding cognitively as what students are expected to know and do as stated in the standards. This alignment examines the alignment not only between contents of standards and assessments, but also the complexity of knowledge required by each. Webb defines an 'acceptable' level of consistency being that "at least 50% of the items corresponding to an objective had to be 'at' or 'above' the level of knowledge of the objective" as a whole. Webb also defines a standard that has between 40% and 50% of its items at or above the depth-of-knowledge of the standard as a whole as having "weakly met" the criteria for Depth-of-Knowledge consistency.

Reading Grade 4	**Percent of Items At or Above**	**Meets Depth of Knowledge YES NO WEAK**
Standard 1	10.1	NO
Standard 2	45.6	WEAK
Standard 3	0	NO
Standard 4	33.3	NO
Standard 5	33.3	NO

Table 2.1 Fourth Grade Reading Depth of Knowledge

Reading Grade 8	**Percent of Items At or Above**	**Meets Depth of Knowledge YES NO WEAK**
Standard 1	4	NO
Standard 2	46.6	WEAK
Standard 3	0	NO
Standard 4	0	NO
Standard 5	50	YES

Table 2.2 Eighth Grade Reading Depth of Knowledge

Reading Grade 10	**Percent of Items At or Above**	**Meets Depth of Knowledge YES NO WEAK**
Standard 1	8.1	NO
Standard 2	71.2	YES

Standard 3	0	NO
Standard 4	0	NO
Standard 5	0	NO

Table 2.3 Tenth Grade Reading Depth of Knowledge

Mathematics Grade 4	**Percent of Items At or Above**	**Meets Depth of Knowledge YES NO WEAK**
Standard 1	50	YES
Standard 2	22.2	NO
Standard 3	71.4	YES
Standard 4	10	NO
Standard 5	35.7	NO
Standard 6	50	YES
Standard 7	0	NO

Table 2.4 Fourth Grade Mathematics Depth of Knowledge

Mathematics Grade 8	**Percent of Items At or Above**	**Meets Depth of Knowledge YES NO WEAK**
Standard 1	100	YES
Standard 2	35.7	NO
Standard 3	38.5	NO
Standard 4	66.7	YES
Standard 5	80	YES
Standard 6	53.9	YES
Standard 7	57.1	YES

T**able 2.5 Eighth Grade Mathematics Depth of Knowledge**

Mathematics Grade 10	**Percent of Items At or Above**	**Meets Depth of Knowledge YES NO WEAK**
Standard 1	0	NO
Standard 2	8.3	NO
Standard 3	30	NO
Standard 4	18.2	NO
Standard 5	71.4	YES
Standard 6	0	NO
Standard 7	11.1	NO

Table 2.6 Tenth Grade Mathematics Depth of Knowledge

Alignment Criterion #3 – Range-of-Knowledge Correspondence

"The range-of-knowledge criterion is used to judge whether a comparable span of knowledge expected of students by a standard is the same as, or corresponds to, the span of knowledge that students need in order to correctly answer the assessment items/activities. The criterion for correspondence between span of knowledge for a standard and the assessment considers the number of objectives within the standards with at least one related assessment item/activity." Webb defines this as acceptable if at least 50% of the objectives for a standard have at least one related assessment item/activity.

Reading Grade 4 Standard	Range of Knowledge Percent of Objectives With One Item/ Meets Criteria
1	100% YES
2	83.3% YES
3	0% NO
4	83.3% YES
5	50% YES

Table 3.1 Fourth Grade Reading Portion of Objectives Assessed by At Least One Related Item/Task

Reading Grade 8 Standard	Range of Knowledge Percent of Objectives With One Item/ Meets Criteria
1	60% YES
2	83.3% YES
3	0% NO
4	57.1% YES
5	40% NO

Table 3.2 Eighth Grade Reading Portion of Objectives Assessed by At Least One Related Item/Task

Reading Grade 10 Standard	Range of Knowledge Percent of Objectives With One Item/ Meets Criteria
1	80% YES
2	83.3% YES
3	0% NO
4	42.9% NO
5	0% NO

Table 3.3 Tenth Grade Reading Portion of Objectives Assessed by At Least One Related Item/Task

Mathematics Grade 4 Standard	Range of Knowledge Percent of Objectives With One Item/ Meets Criteria
1	60% YES
2	100% YES
3	100% YES
4	100% YES
5	75% YES
6	50% YES
7	100% YES

Table 3.4 Fourth Grade Mathematics Portion of Objectives Assessed by At Least One Related Item/Task

Mathematics Grade 8 Standard	Range of Knowledge Percent of Objectives With One Item/ Meets Criteria
1	60% YES
2	100% YES
3	100% YES
4	80% YES
5	83.3% YES
6	80% YES
7	80% YES

Table 3.5 Eighth Grade Mathematics Portion of Objectives Assessed by At Least One Related Item/Task

Mathematics Grade 10 Standard	Range of Knowledge Percent of Objectives With One Item/ Meets Criteria
1	20% NO
2	50% YES
3	80% YES
4	100% YES
5	100% YES
6	66.7% YES
7	80% YES

Table 3.6 Tenth Grade Mathematics Portion of Objectives Assessed by At Least One Related Item/Task

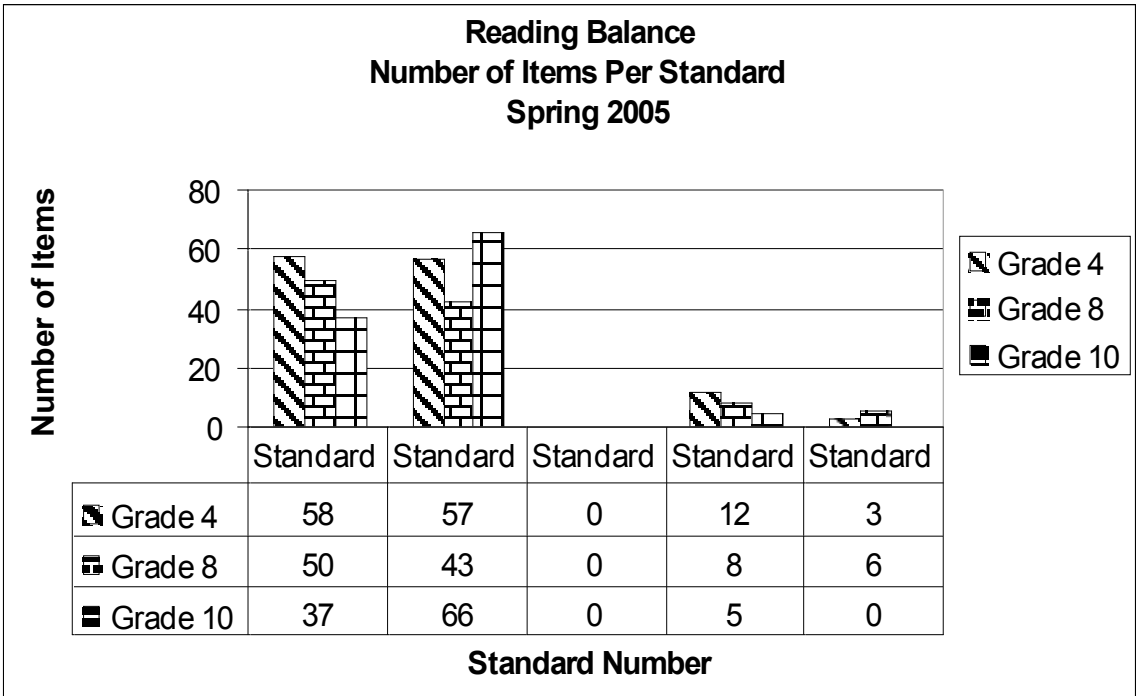
Alignment Criterion #4 – Balance of Representation

Assessment instruments and standards need to be comparable not only in breadth of knowledge (categorical concurrence) and depth of knowledge (depth-of-knowledge consistency) but also in equal distribution of the knowledge. The criterion of Balance of Representation is used to "indicate the extent to which assessment items are evenly distributed across objectives." For purposes of this study, a less formal method of examining Balance of Representation is used. The tests do not meet the criteria for Balance of Representation, as can be seen by looking at the two following graphs of item distribution.

In the area of reading, at all three grade levels, the test is out of balance with regard to standards 1-2 in comparison with standards 3-6

Tables 1.1 and 1.2 display the balance of items across the standards.
Tables 1.3 and 1.4 display the balance of items across the objectives.

Figure 1.1 Reading Balance – Number of Items per Standard

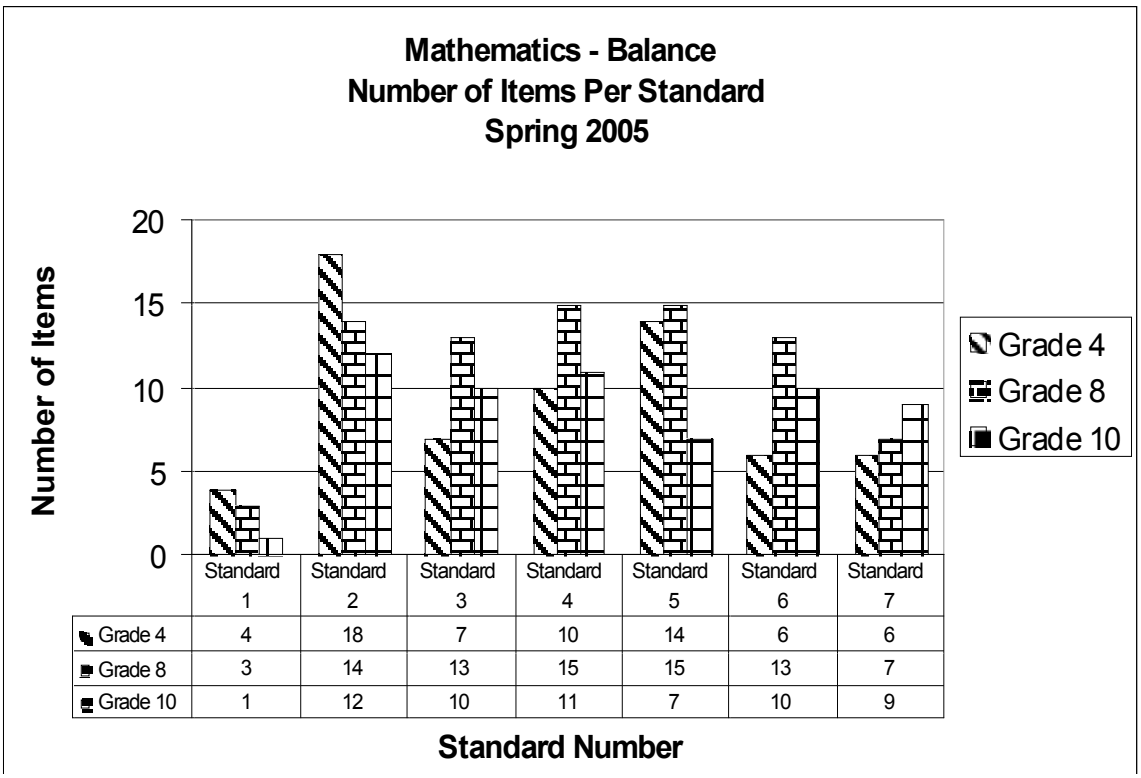


	Standard	Standard	Standard	Standard	Standard
Grade 4	58	57	0	12	3
Grade 8	50	43	0	8	6
Grade 10	37	66	0	5	0

Question: Are the items/tasks evenly distributed across the standards?

In the area of mathematics, at all three grade levels, the test is out of balance with regard to standard 1 in comparison with the other six standards.

Figure 1.2 Mathematics Balance – Number of Items per Standard

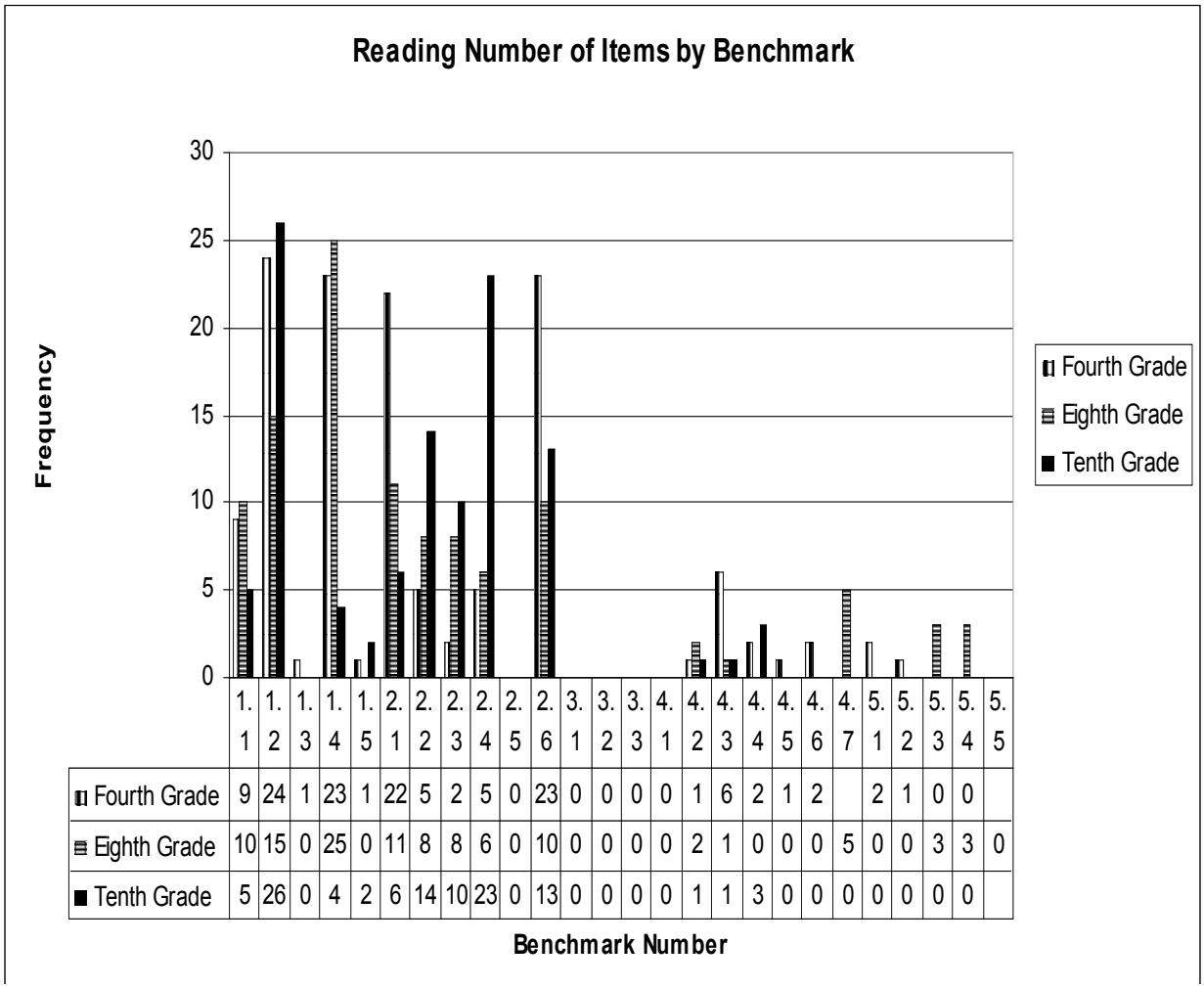


	Standard 1	Standard 2	Standard 3	Standard 4	Standard 5	Standard 6	Standard 7
Grade 4	4	18	7	10	14	6	6
Grade 8	3	14	13	15	15	13	7
Grade 10	1	12	10	11	7	10	9

Question: Are the items/tasks evenly distributed across the standards?

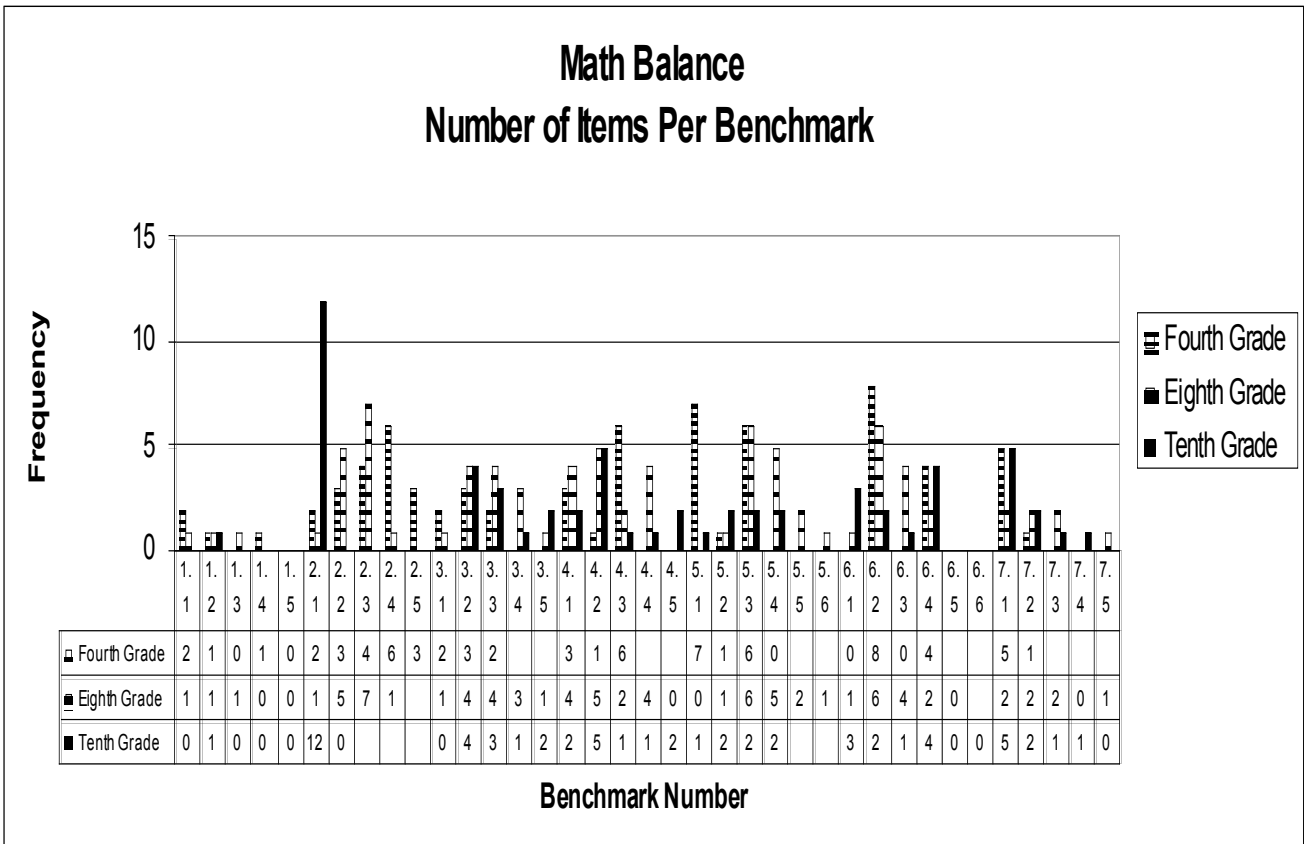
Figure 1.3 Reading Balance – Number of Items per Benchmark

Question: Are the items/tasks evenly distributed across the objectives?



	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	2.6	3.1	3.2	3.3	4.1	4.2	4.3	4.4	4.5	4.6	4.7	5.1	5.2	5.3	5.4	5.5
Fourth Grade	9	24	1	23	1	22	5	2	5	0	23	0	0	0	0	1	6	2	1	2		2	1	0	0	
Eighth Grade	10	15	0	25	0	11	8	8	6	0	10	0	0	0	0	2	1	0	0	0	5	0	0	3	3	0
Tenth Grade	5	26	0	4	2	6	14	10	23	0	13	0	0	0	0	1	1	3	0	0	0	0	0	0	0	

Figure 1.4 Mathematics Balance – Number of Items per Benchmark



	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	4.5	5.1	5.2	5.3	5.4	5.5	5.6	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.2	7.3	7.4	7.5
Fourth Grade	2	1	0	1	0	2	3	4	6	3	2	3	2			3	1	6			7	1	6	0			0	8	0	4			5	1				
Eighth Grade	1	1	1	0	0	1	5	7	1		1	4	4	3	1	4	5	2	4	0	0	1	6	5	2	1	1	6	4	2	0		2	2	2	0	1
Tenth Grade	0	1	0	0	0	12	0				0	4	3	1	2	2	5	1	1	2	1	2	2	2			3	2	1	4	0	0	5	2	1	1	0

Question: Are the items/tasks evenly distributed across the Benchmarks?

Alignment Data – State Standards Level

Reading

Grade 4

Figure 4.1 Grade 4 Reading – Depth of Knowledge By Item

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Content Standard 1: Student construct meaning as they comprehend, interpret, and respond to what they read.	**3**		**1 –32.8 %** **2 –56.9%** **3 –6.9%** **4 –3.4%** **Total Items = 58**	
1.1. make predictions and connections between new materials and previous information/ experience	2	7 13 20 21 23 24 51 61 67	1 – 5 2 – 3 3 – 1 4 – 0	
1.2. incorporate new print/non-print information into existing knowledge to draw conclusions and make applications	3	3 4 11 12 13 16 17 18 19 26 27 28 30 23 48 49 53 56 57 60 62 63 65 66	1 – 6 2 – 17 3 – 1 4 – 0	
1.3. provide oral, written, and/or artistic responses to ideas and feelings	3	22	1-0 2-0 3-0 4-1	

generated by the reading material				
1.4. demonstrate basic understanding of main ideas and some supporting details	2	8 10 14 16 17 18 21 28 29 30 49 52 66 59 60 62 63 65 67	1- 8 2- 13 3- 2 4- 0	
1.5. accurately retell key elements of appropriate reading material	1	22	1-0 2-0 3-0 4- 1	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Content Standard 2: Students apply a range of skills and strategies to read.	**2**		**1 –54.4 %** **2 –45.6%** **3 –0%** **4 –0%** **Total Items =57**	
2.1. decode unknown words combining the elements of phonics, grammatical structures, analysis of word parts, and context to understand reading material.	1	1 2 3 4 5 6 7 8 14 15 16 11 12 19 20 23 25 31 46 48	1- 14 2- 8 3-0 4-0	
2.2. demonstrate understanding of	2	24 47	1-2 2-3	

literary elements (e.g., plot, character, setting, problem, solution)		51 52 55	3-0 4-0	
2.3 identify literary devises (e.g., figurative language and exaggeration).	2	32 55	1-0 2-2 3-0 4-0	
2.4. use features and organization of fiction and non fiction materials to comprehend complex materials (e.g., paragraphs, chapters, titles, indexes, tables of contents, graphs, charts, visuals).	3	5 9 50 64 65	1-0 2-5 3-0 4-0	
2. 5. adjust fluency, rate, and style of reading to the purpose of the materials with guidance	2			
2.6. develop vocabulary through the use of word parts, auditory clues, and reference sources (e.g., dictionary, thesaurus, glossary)	2	1 2 5 6 7 11 10 12 13 14 15 17 18 19 20 25 27 48 58	1-15 2-8 3-0 4-0	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Content Standard 3: Students set goals, monitor, and evaluate their progress in reading.	**3**		**1 – 0%** **2 –0%** **3 –0%** **4 –0%** **Total Items = 0**	
3.1 Articulate strategies used to self monitor reading	3			

progress and to overcome reading difficulties with guidance from the teacher				
3.2 Describe reading successes and set reading goals	3			
3.3 Select authors, subjects, and print and non print materials to share with others.	2			

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Content Standard 4: Students select, read, and respond to print and on print materials for a variety of purposes.	**3**		**1 – 0%** **2 –66.7%** **3 –16.7%** **4 –16.7%** **Total Items = 12**	
4.1. identify a variety of purposes for reading (e.g., personal satisfaction, lifelong reading habits)	3			
4.2. solve a problem or answer a question through reading (e.g., signs, labels, instruction)	3	67	1-0 2-0 3-1 4-0	
4.3. perform tasks for a variety of purposes by reading (e.g., recipes, directions, schedules, maps, tables, charts)	3	9 59 60 61 63 67	1-0 2-5 3-1 4-0	
4.4. read and provide oral, written, and/or artistic responses to diverse perspectives, cultures, and issues in traditional and contemporary literature	3	9 22	1-0 2-1 3-0 4-1	
4.5. read a variety of sources to demonstrate an understanding of current events (e.g., newspapers, magazines)	3	10	1-0 2-1 3-0 4-0	
4.6. read and interpret	2	22	1-0	

information from a variety of documents and sources (e.g., memos, directories, maps, tables, schedules, as well as other technological material)		66	2-1 3-0 4-1	
	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Content Standard 5: Students gather, analyze, synthesize, and evaluate information from a variety of sources, and communicate their findings in ways appropriate for their purposes and audiences.	**3**		**1 – 0%** **2 –66.7%** **3 –33.3%** **4 –0%** **Total Items = 3**	
5.1. identify and summarize similarities and differences using a single element such as character within a text and between sources of information	2	54 67	1-0 2-1 3-1 4-0	
5.2. make connections, integrate, and organize information from multiple sources	3	54	1-0 2-1 3-0 4-0	
5.3. recognize authors' points of view	2			
5.4. distinguish fact from opinion in various print and non print material.	3			

Reading
Grade 8

Figure 4.2 Grade 8 Reading – Depth of Knowledge By Item

	Depth of Knowledge	Item Numbers	Depth of Knowledge	
Content Standard 1: Student construct meaning as they comprehend, interpret, and respond to what they read.	**3**		**1 – 20%** **2 –76%** **3 –4%** **4 –0%** **Total Items = 50**	
1.1. make predictions and clearly describe, with details, meaningful connections between new material and previous information/ experiences	2	3 6 8 9 10 12 13 15 22 27	1-0 2-9 3-1 4-0	
1.2. compare and contrast important print/ non print information with existing knowledge to draw conclusions and make application	3	11 12 16 21 24 26 27 31 32 49 55 59 60 62 64	1-4 2-11 3-0 4-0	
1.3. interpret and provide oral, written, and/or artistic responses to ideas and feelings generated by the reading materials and compare responses with peers	3			
1.4. demonstrate understanding of main ideas and select important supporting facts and details	2	2 3 6 8 9 10	1-6 2-18 3-1 4-0	

		12 13 16 22 24 25 26 27 28 31 32 46 49 50 55 59 60 62 64		
1.5. provide accurate, detailed summaries using key elements of appropriate reading material	1			

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Content Standard 2: Students apply a range of skills and strategies to read.	**2**		**1 – 53.5%** **2 –41.9%** **3 –4.7%** **4 –0%** **Total Items = 43**	
2.1. decode unknown words combining the elements of phonic, grammatical structures, analysis of word parts, and context to understand reading material.	1	1 7 14 15 17 23 30 51 56 58 61	1-9 2-2 3-0 4-0	
2.2. demonstrate understanding of an analyze literary elements (e.g., plot, character, setting, point of view, conflict)	2	11 18 19 20 22 29 52 54	1-2 2-5 3-1 4-0	
2.3. identify and compare literary devices (e.g., figurative language,	3	8 18 19 20	1-2 2-5 3-1 4-0	

exaggeration, irony, humor, dialogue)		29 52 54 67		
2.4. use features and organization of fiction and nonfiction material to comprehend complex materials (e.g., paragraphs, chapters, titles, indexes, tables of contents, graphs, charts, visuals)	3	2 4 5 21 53 63	1-1 2-5 3-0 4-0	
2.5. adjust fluency, rate, and style of reading to the content and purpose of the material	3			
2.6. develop vocabulary through the use of context clues, analysis of word parts, auditory clues, and reference sources, and construct general and specialized vocabularies related to specific academic areas, culture, and technology	2	1 7 14 15 17 25 30 51 56 61	1-9 2-1 3-0 4-0	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Content Standard 3: Students set goals, monitor, and evaluate their progress in reading.	**3**		**1 – 0%** **2 –0%** **3 –0%** **4 –0%** **Total Items =0**	
3.1. articulate and evaluate strategies to self-monitor reading progress, overcome reading difficulties, and seek guidance as needed	3			
3.2. monitor reading successes and set reading goals	3			
3.3. select authors, subjects, and print and on print material, expressing reasons for	2			

recommendations				
	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Content Standard 4: Students select, read, and respond to print and on print materials for a variety of purposes.	**3**		**1 – 62.5%** **2 –37.5%** **3 –0%** **4 –0%** **Total Items = 8**	
4.1. establish and adjust the purposes for reading (e.g., personal satisfaction, lifelong reading habits, sharing and reflecting upon their reading)	3			
4.2. read to organize and understand information, and to use materials to investigate a topic (e.g., personal satisfaction, lifelong reading habits, sharing and reflecting upon their reading)	3	5 66	1-1 2-1 3-0 4-0	
4.3. read, interpret and apply information to perform specific tasks (e.g., maps, travel books, first aid manuals, catalogs)	3	66	1-1 2-0 3-0 4-0	
4.4. read, analyze, and provide oral, written, and/or artistic response to traditional and contemporary literature	3			
4.5. identify recurring themes, perspectives, cultures, and issues by reading (e.g., identity, conflict, change)	3			
4.6. read, and identify civic and social responsibilities by interpreting and analyzing social rules (e.g., handbooks, newspapers, other information)	2			
4.7. identify, locate, read and interpret	2	46 47	1-3 2-2	

information from a variety of documents and sources (e.g., graphs, tables, policy statements, television, Internet)		48 49 50	3-0 4-0	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Content Standard 5: Students gather, analyze, synthesize, and evaluate information from a variety of sources, and communicate their findings in ways appropriate for their purposes and audiences.	**3**		**1 – 16.7%** **2 –33.3%** **3 –50.0%** **4 –0%** **Total Items = 6**	
5.1. compare and contrast information and textual elements in print and non print material	2			
5.2. make connections, explain relationships among a variety of sources, and integrate similar information	3			
5.3. recognize authors' points of view and purposes	2	57 58 67	1-0 2-1 3-2 4-0	
5.4. recognize authors' use of language and literary devices to influence readers.	3	23 50 67	1-1 2-1 3-1 4-0	
5.5. recognize, express, and defend a point of view	4			

Reading
End of Grade 10

Figure 4.3 Grade 10 Reading – Depth of Knowledge By Item

	Depth of Knowledge	Item Numbers	Depth of Knowledge	
Content Standard 1: Student construct meaning as they comprehend, interpret, and respond to what they read.	**3**		**1 –21.6%** **2 –70.2%** **3 –8.1%** **4 –0%** **Total Items = 37**	
1.1. make predictions and describe inferences and connections within material and between new materials and previous information/ experiences	3	10 28 30 66 70	1-0 2-5 3-0 4-0	
1.2. integrate new important print/ non print information with their existing knowledge to draw conclusions and make application	2	1 3 4 6 7 8 10 13 16 17 18 20 24 25 26 28 34 35 36 60 61 65 66 68 69 70	1-7 2-19 3-0 4-0	
1.3. provide oral, written, and/or artistic responses to ideas and feelings generated by the reading material,	3			

providing examples of the way these influence one's life and role in society				
1.4. demonstrate understanding of main ideas and formulate arguments using supporting evidence	2	18 22 30 72	1-1 2-1 3-2 4-0	
1.5. accurately paraphrase reading materials, reflecting tone and point of view	2	60 72	1-0 2-1 3-1 4-0	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Content Standard 2: Students apply a range of skills and 1strategies to read.	**2**		**1 –28.8 %** **2 –66.7%** **3 –4.5%** **4 –0%** **Total Items = 66**	
2.1. decode unknown words combining the elements of phonics, grammatical structures, analysis of word parts, and context to understand reading material	1	9 11 14 19 56 64	1-4 2-2 3-0 4-0	
2.2. identify, analyze, and evaluate literary elements (e.g., plot, character, theme, setting, point of view, conflict)	3	5 12 15 23 25 26 27 28 29 31 52 53 54 55	1-2 2-11 3-1 4-0	
2.3. identify, analyze and evaluate the use of literary devices (e.g., figurative language, exaggeration, irony, humor, dialogue, satire, symbolism)	3	2 5 12 15 22 27 29 51 54	1-2 2-7 3-1 4-0	

		55		
2.4. use features and organization of fiction and nonfiction materials to comprehend increasingly complex material (e.g., paragraphs, chapters, titles, indexes, tables of contents, graphs, charts, visuals, and methods of organization)	3	3 4 5 17 19 21 29 32 33 37 53 57 58 59 60 62 63 65 67 68 69 70 73	1-3 2-19 3-1 4-0	
2.5. adjust fluency, rate and style of reading to content and purpose of the material	2			
2.6. develop vocabulary through the use of context clues, analysis of word parts, auditory clues, and reference sources, and expand and refine vocabulary related to specific academic areas, culture, and technology	2	6 7 8 9 10 11 14 15 16 19 21 56 64	1-8 2-5 3-0 4-0	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Content Standard 3: Students set goals, monitor, and evaluate their progress in reading.	**3**		**1 –0%** **2 –0%** **3 –0%** **4 –0%** **Total Items =0**	
3.1. articulate and evaluate strategies to solve reading problems, self-	3			

monitory progress, and direct one's own reading				
3.2. analyze reading successes and attainment of reading goals	3			
3.3. select authors, subjects, and print and non print materials, expressing reasons for recommendations, and information and insights gained.	3			

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Content Standard 4: Students select, read, and respond to print and on print materials for a variety of purposes.	**3**		**1 –20 %** **2 –80%** **3 –0%** **4 –0%** **Total Items = 5**	
4.1. integrate purposes for reading into daily life (e.g., personal satisfaction, lifelong reading habits, reading as a leisure activity, sharing, and reflecting upon the reading)	3			
4.2. read to evaluate appropriate resource materials for a specific task	3	21	1-1 2-0 3-0 4-0	
4.3. locate, read, analyze and interpret materials to investigate a question, topic, or issue (e.g., reference material, pamphlets, book excerpts, articles, letters, and electronic information)	3	71	1-0 2-1 3-0 4-0	
4.4. read, analyze, and synthesize information to perform complex tasks for a variety of purposes (e.g., schedules, maps, instruction, consumer reports, and technical	3	31 32 33	1-0 2-3 3-0 4-0	

manuals.				
4.5. read and analyze works of various authors (e.g., diverse cultures, perspectives and issues, recurring themes)	3			
4.6. read, evaluate, and create material and documents related to social and civic responsibilities (e.g., letters to the editor, posters)	3			
4.7. locate, read, analyze, and evaluate information sources (e.g., manuals, instructions, flowcharts, television, Internet)	3			
	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Content Standard 5: Students gather, analyze, synthesize, and evaluate information from a variety of sources, and communicate their findings in ways appropriate for their purposes and audiences.	**3**		**1 – 0%** **2 –0%** **3 –0%** **4 –0%** **Total Items = 0**	
5.1. compare and contrast information and broad themes within and among a variety of information sources	2			
5.2. logically synthesize information from a complex range of print and on print sources	3			
5.3. apply basic principles of formal logic to print and non print material.	2			
5.4. analyze use of evidence, logic, language devices, and bias as strategies to influence readers	3			

Mathematics
Grade 4

Figure 4.4 Grade 4 Mathematics – Depth of Knowledge By Item

	Depth of Knowledge Standards	Item Numbers	Depth of Knowledge Items	
Mathematics Content Standard 1: Students engage in the mathematical process of problem solving and reasoning, estimation, communication, connections and applications, and using appropriate technology.	**3**		1- 0 2- 50% **3- 50%** 4-0 Total Items 4	
1.1. solve problems from many contexts using a variety of strategies (e.g., estimate, make a table, look for a pattern, and simplify the problem). Explain the methods for solving these problems.	3	64 68	1- 2- 1 3- 1 4-	
1.2. apply estimation strategies throughout the problem-solving process.	2	47	1- 2- 1 3- 4-	
1.3. communicate mathematical ideas in a variety of ways (e.g., written, verbal, concrete, pictorial, graphical, algebraic).	2	68	1- 2- 3- 4-	
1.4. recognize and investigate the relevance and usefulness of mathematics through applications, both in and out of school.	3		1- 2- 3- 1 4-	
1.5. select and use appropriate technology to enhance mathematical understanding.	2		1- 2- 3- 4-	

Appropriate technology may include, but is not limited to, paper and pencil, calculator, and computer.				
	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 2: Students demonstrate understanding of and an ability to use numbers and operations.	**2**		1- 77.8% **2-22.2%** 3-0 4-0 Total Items18	
2.1. exhibit connections between the concrete and symbolic representation of a problem or concept.	2	23 29	1- 2 2- 3- 4-	
2.2. use the number system by counting, grouping and applying place value concepts.	2	13 16 26	1- 3 2- 3- 4-	
2.3. model, explain, and use basic facts, the operations of addition and subtraction of whole numbers, and mental mathematics.	3	24 44 65 67	1- 3 2- 1 3- 4-	
2.4. model and explain multiplication and division of whole numbers.	3	2 19 24 29 28 66	1- 4 2- 2 3- 4-	
2.5. model and explain part/whole relationships in everyday situations.	3	20 23 56	1- 2 2- 1 3- 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 3: Students use algebraic concepts, processes, and language to model and solve a variety of real-world and	**2**		1- 28.6% **2- 71.4%** 3-0 4-0 Total Items 7	

mathematical problems.				
3.1. use symbols (e.g., boxes or letters) to represent numbers in simple situations.	2	32 27	1- 1 2- 1 3- 4-	
3.2. explore the use of variables and open sentences to express relations (e.g., missing addend).	3	8 32 55	1- 1 2- 2 3- 4-	
3.3. use inverse operations and other strategies to solve number sentences.	2	8 60	1- 2- 2 3- 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 4: Students demonstrate understanding of shape and an ability to use geometry.	**2**		1- 90% **2- 10%** 3-0 4-0 Total Items 10	
4.1. describe, model, and classify two- and three-dimensional shapes.	2	12 17 52	1- 3 2- 3- 4-	
4.2. investigate and predict results of combining, subdividing, and changing shapes.	2	14	1- 1 2- 3- 4-	
4.3. identify lines of symmetry, congruent and similar shapes, and positional relationships.	1	3 9 30 38 63 54	1- 5 2- 1 3- 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 5: Students demonstrate understanding of measurable attributes and an ability to use measurement processes.	**2**		1- 64.3% **2- 35.7%** 3-0 4-0 Total Items 14	
5.1. estimate, measure, and	2	1 15	1- 5 2- 2	

investigate length, capacity, weight, mass, area, volume, time, and temperature.		39 45 46 53 61	3- 4-	
5.2. develop the process of measuring and concepts related to units of measurement, including standard units (English and metric) and nonstandard units.	2	5	1- 2- 1 3- 4-	
5.3. apply measurement skills to everyday situations.	2	15 39 45 46 53 61	1- 4 2- 2 3- 4-	
5.4. select and use appropriate tools and techniques.	2		1- 2- 3- 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 6: Students demonstrate understanding of and an ability to use data analysis, probability, and statistics.	**2**		1- 50% **2- 50%** 3-0 4-0 Total Items 12	
6.1 collect, organize, and display data.	2		1- 2- 3- 4-	
6.2 construct, read, and interpret displays of data, including graphs.	2	4 7 18 25 28 50 57 62	1- 3 2- 5 3- 4-	
6.3 formulate and solve problems that involve collecting and analyzing data.	3		1- 2- 3- 4-	
6.4 demonstrate basic concepts of chance (e.g., equally	2	18 35 37	1- 3 2- 1 3-	

likely events, simple probabilities).		48	4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 7: Students demonstrate understanding of and an ability to use patterns, relations and functions.	**3**		1- 83.3% 2- 16.7% **3-0** 4-0 Total Items 6	
7.1 recognize, describe, extend, and create a variety of patterns.	3	6 11 21 51 59	1- 4 2- 1 3- 4-	
7.2 represent and describe mathematical and real-world relationships.	3	10	1- 1 2- 3- 4-	

Mathematics
Grade 8

Figure 4.5 Grade 8 Mathematics – Depth of Knowledge By Item

	Depth of Knowledge Standards	Item Numbers	Depth of Knowledge Items	
Mathematics Content Standard 1: Students engage in the mathematical processes of problem solving and reasoning, estimation, communication, connections and applications, and using appropriate technology.	**2**		1- 0 **2-100%** 3-0 4-0 Total Items 3	
1.1. formulate and solve multi-step and nonroutine problems using a variety of strategies. Generalize methods to new problem situations.	3	8	1- 2- 1 3- 4-	
1.2. select and apply appropriate estimation strategies throughout the problem-solving process.	2	2	1- 2- 1 3- 4-	
1.3. interpret and communicate mathematical ideas and logical arguments using correct mathematical terms and notations.	3	8	1- 2- 1 3- 4-	
1.4. recognize and investigate the relevance and usefulness of mathematics through applications, both in and out of school.	3		1- 2- 3- 4-	
1.5. select and use appropriate technology to enhance mathematical understanding. Appropriate technology may	2		1- 2- 3- 4-	

include, but is not limited to, paper and pencil, calculator, computer and data collection devices.				

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 2: Students demonstrate understanding of and an ability to use numbers and operations.	**2**		1- 64.3% **2- 35.7%** 3-0 4-0 Total Items 14	
2.1. use the four basic operations with whole numbers, fractions, decimals, and integers.	1	6	1- 1 2- 3- 4-	
2.2. use mental mathematics and number sense in using order of operations, and order relations for whole numbers, fractions, decimals, and integers.	2	6 27 35 55 67	1- 3 2- 2 3- 4-	
2.3. use the relationships and applications of ratio, proportion, percent and scientific notation.	2	2 19 28 45 51 61 65	1- 5 2- 2 3- 4-	
2.4. develop and apply number theory concepts (e.g., primes, factors and multiples) in real-world and mathematical problem situations.	2	59	1- 2- 1 3- 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 3: Students use algebraic concepts, processes, and language to model and solve a variety of real-world and mathematical	**2**		1- 61.5% **2- 30.8%** 3- 7.7% 4-0 Total Items 13	

problems.				
3.1. understand the concepts of variable, expression and equation.	1	53	1- 1 2- 3- 4-	
3.2. represent situations and number patterns using tables, graphs, verbal rules, equations, and models.	2	29 49 53 57	1- 4 2- 3- 4-	
3.3. recognize and use the general properties of operations (e.g., the distributive property).	1	28 46 48 66	1- 2 2- 2 3- 4-	
3.4 solve linear equations using concrete, numerical and algebraic methods.	2	23 25 66	1- 2- 2 3- 1 4-	
3.5 investigate inequalities and nonlinear relationships informally.	3	57	1- 1 2- 3- 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 4: Students demonstrate understanding of shape and an ability to use geometry.	**2**		1- 33.3% **2- 66.7%** 3- 0 4-0 Total Items 15	
4.1. identify, describe, construct, and compare plane and solid geometric figures.	1	9 16 38 60	1- 3 2- 1 3- 4-	
4.2. understand and apply geometric properties and relationships (e.g., the Pythagorean Theorem).	2	12 19 20 38 60	1- 2 2- 3 3- 4-	
4.3 represent geometric figures on a coordinate grid.	2	50 64	1- 2- 2 3- 4-	
4.4. explore properties and transformations of geometric figures.	2	3 37 56 64	1- 2- 4 3- 4-	

4.5. use geometry as a means of describing the physical world.	3		1- 2- 3- 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 5: Students demonstrate understanding of measurable attributes and an ability to use measurement processes.	**2**		1- 20% **2- 80%** 3-0 4-0 Total Items15	
5.1. estimate, make, and use measurements to describe, compare, and/or contrast objects in real-world situations.	2		1- 2- 3- 4-	
5.2. select and use appropriate units and tools to measure to a level of accuracy required in a particular setting.	2	26	1- 1 2- 3- 4-	
5.3. apply the concepts of perimeter, area, volume and capacity, weight and mass, angle measure, time and temperature.	2	7 13 15 18 20 26	1- 1 2- 5 3- 4-	
5.4. demonstrate understanding of the structure and use of systems of measurement, including English and metric.	2	4 7 15 17 18	1- 2- 5 3- 4-	
5.5. use the concepts of rates and other derived and indirect measurements.	2	4 21	1- 1 2- 1 3- 4-	
5.6 demonstrate relationships between formulas and procedures for determining area and volume.	3	54	1- 2- 1 3- 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	

Mathematics Content Standard 6: Students demonstrate understanding of and an ability to use data analysis, probability, and statistics.	**2**		1- 46.2% **2- 46.2%** 3- 7.7% 4-0 Total Items 13	
6.1. systematically collect, organize and describe data.	2	52	1- 1 2- 3- 4-	
6.2. construct, read, and interpret tables, charts, and graphs.	2	5 10 22 36 62 68	1- 3 2- 2 3- 1 4-	
6.3. draw inferences, construct, and evaluate arguments based on data analysis and measures of central tendency.	3	5 23 30 63	1- 1 2- 3 3- 4-	
6.4. construct sample spaces and determine the theoretical and experimental probabilities of events.	3	11 58	1- 1 2- 1 3- 4-	
6.5. make predictions based on experimental results or probabilities.	3		1- 2- 3- 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 7: Students demonstrate understanding of and an ability to use patterns, relations and functions.	**2**		1- 42.9% **2- 57.1%** 3-0 4-0 Total Items 7	
7.1. describe, extend, analyze and create a variety of patterns and functions.	2	1 39	1- 2- 2 3- 4-	
7.2. describe and represent relationships with tables, graphs and rules.	3	29 44	1- 2 2- 3- 4-	

7.3. analyze functional relationships to explain how a change in one quantity results in a change in another.	2	14 24	1- 2- 2 3- 4-	
7.4. use patterns and functions to represent and solve problems.	2		1- 2- 3- 4-	
7.5. describe functions using graphical, numerical, physical, algebraic, and verbal models or representations.	2	53	1- 1 2- 3- 4-	

Mathematics
End of Grade 10

Figure 4.6 Grade 10 Mathematics – Depth of Knowledge By Item

	Depth of Knowledge Standards	Item Numbers	Depth of Knowledge Items	
Mathematics Content Standard 1: Student engage in the mathematical processes of problem solving and reasoning, estimation, communication, connections and applications, and using appropriate technology.	**3**		1- 100% 2-0 **3-0** 4-0 Total Items 1	
1.1. recognize and formulate problems from situations within and outside mathematics and apply solution strategies to those problems.	3		1- 2- 3- 4-	
1.2. select, apply and evaluate appropriate estimation strategies throughout the problem-solving process.	3	55	1- 1 2- 3- 4-	
1.3. formulate definitions, make and justify inferences, express generalizations and communicate mathematical ideas and relationships.	2		1- 2- 3- 4-	
1.4. apply and translate among different representations of the same problem situation or of the same mathematical concept. Model connections between	3		1- 2- 3- 4-	

problem situations that arise in disciplines other than mathematics.				
1.5. select and use appropriate technology to enhance mathematical understanding. Appropriate technology may include, but is not limited to, paper and pencil, calculator, computer, and data collection devices.	2		1- 2- 3- 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 2: Students demonstrate understanding of and an ability to use numbers and operations.	**2**		1- 91.7% **2- 8.3%** 3-0 4-0 Total Items12	
2.1. use and understand the real number system, its operations, notations, and the various subsystems.	2	1 6 11 13 18 42 49 50 53 62 72	1- 11 2- 1 3- 4-	
2.2. use definitions and basic operations of the complex number system.	2		1- 2- 3- 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 3: Students use algebraic concepts, processes, and language to model and solve a variety of real-world and mathematical	**2**		1- 70% **2- 20%** 3- 10% 4-0 Total Items 10	

problems.				
3.1. use algebra to represent patterns of change.	2		1- 2- 3- 4-	
3.2. use basic operations with algebraic expressions.	2	40 43 44 57	1- 3 2- 1 3- 4-	
3.3. solve algebraic equations and inequalities: linear, quadratic, exponential, logarithmic, and power.	2	27 37 71	1- 2 2- 1 3- 4-	
3.4. solve systems of algebraic equations and inequalities, including use of matrices.	2	20	1- 1 2- 3- 4-	
3.5. use algebraic models to solve mathematical and real-world problems.	3	56 73	1- 1 2- 3- 1 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Standard 4: Students demonstrate understanding of shape and an ability to use geometry.	**2**		1- 81.8% **2- 18.2%** 3-0 4-0 Total Items 11	
4.1. construct, interpret, and draw three-dimensional objects.	1	41 58	1- 2 2- 3- 4-	
4.2. classify figures in terms of congruence and similarity and apply these relationships.	2	23 25 28 38 64	1- 3 2- 2 3- 4-	
4.3. translate between synthetic and coordinate representations.	2	60	1- 1 2- 3- 4-	
4.4. deduce properties of figures using transformations, coordinates, and vectors in problem solving.	2	4	1- 1 2- 3- 4-	
4.5. apply	2	5	1- 2	

trigonometric ratios (sine, cosine and tangent) to problem situations involving triangles.		63	2- 3- 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 5: Students demonstrate understanding of measurable attributes and an ability to use measurement processes.	**2**		1- 28.6% **2- 71.4%** 3-0 4-0 Total Items 7	
5.1. apply concepts of indirect measurements (e.g., using similar triangles to calculate a distance).	2	29	1- 1 2- 3- 4-	
5.2. use dimensional analysis to check reasonableness of procedures.	2	15 39	1- 2- 2 3- 4-	
5.3. investigate systems of derived measures (e.g., km/sec, g/cm$^{3)}$.	2	2 32	1- 2- 2 3- 4-	
5.4. apply the appropriate concepts of estimates in measurement, error in measurement, tolerance, and precision.	2	10 54	1- 1 2- 1 3- 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 6: Students demonstrate understanding of and an ability to use data analysis, probability, and statistics.	**3**		1- 60% 2- 40% **3-0** 4-0 Total Items 10	
6.1. use curve fitting to make predictions from data.	3	17 52 69	1- 1 2- 2 3- 4-	
6.2. apply measures	3	3	1- 2	

of central tendency and demonstrate understanding of the concepts of variability and co4rrelation.		7	2- 3- 4-	
6.3. select an appropriate sampling method for a given statistical analysis.	3	59	1- 1 2- 3- 4-	
6.4. use experimental probability, theoretical probability, and simulation methods to represent and solve problems, including expected values.	3	16 22 30 67	1- 2 2- 2 3- 4-	
6.5. design a statistical experiment to study a problem and communicate the outcomes.	4		1- 2- 3- 4-	
6.6. describe, in general terms, the normal curve and use its properties to answer questions about sets of data that are assumed to be normally distributed.	3		1- 2- 3- 4-	

	Depth of Knowledge	**Item Numbers**	**Depth of Knowledge**	
Mathematics Content Standard 7: Students demonstrate understanding of and an ability to use patterns, relations and functions.	**3**		1- 55.6% 2- 33.3% **3- 11.1%** 4-0 Total Items 9	
7.1. describe functions and their inverses using graphical, numerical, physical, algebraic, and verbal mathematical models or representations.	3	21 24 26 66 68	1- 3 2- 2 3- 4-	
7.2. analyze the graphs of the families of polynomial, rational, power, exponential, logarithmic, and	2	51 60	1- 2 2- 3- 4-	

periodic functions.				
7.3. analyze the effects of parameter changes on the graphs of functions and relations, including translations.	3	73	1- 2- 3- 1 4-	
7.4. model real-world phenomena with a variety of functions.	3	21	1- 2- 1 3- 4-	
7.5. use graphing for parametric equations, three-dimensional equations, and recursive relations.	3		1- 2- 3- 4-	

Alignment Data – Spring 2005 Item Level

Reading Grade 4

Table 5.1 Grade 4 Reading – Alignment and Depth of Knowledge By Item

Item	Cog Level	Standards	Notes
1	1	2.1 2.6	
2	1	2.1 2.6	
3	2	2.1 1.2	
4	2	2.1 1.2	
5	2	2.1 2.4 2.6	
6	1	2.1 2.6	
7	1	1.1 2.1	
8	2	2.1 1.4	
9	2	2.4 4.2 4.3	
10	2	1.4 2.6 4.5	
11	2	2.1 2.6 1.2	
12	2	2.1 2.6 1.2	
13	2	1.1 1.2 2.6	
14	1	1.4 2.1 2.6	
15	1	2.1 2.6	
16	2	1.2 1.4 2.1	
17	1	1.4 1.2 2.6	
18	1	1.2 1.4 2.6	
19	1	1.2 2.1 2.6	
20	1	1.1 2.1 2.6	
21	1	1.1 1.4	
22	3	1.3 4.4 4.6	
23	1	1.1 2.1 2.6	
24	1	1.1 2.2	
25	1	2.1 2.6	
26	2	1.2 2.6	
27	2	1.2 2.6	
28	3	1.2 1.4	
29	2	1.4 2.6	
30	1	1.2 1.4	
31	1	2.1 2.6	
32	2	1.2 2.3	
33	Field Test Item		
34	Field Test Item		
35	Field Test Item		
36	Field Test Item		
37	Field Test Item		
38	Field Test Item		
39	Field Test Item		
40	Field Test Item		
41	Field Test Item		
42	Field Test Item		
43	Field Test Item		

44	Field Test Item		
45	Field Test Item		
46	1	1.4 2.1	
47	2	2.1 2.2	
48	1	1.2 2.1 2.6	
49	2	1.2 1.4	
50	2	2.4	
51	2	1.1 2.2	
52	1	1.4 2.2	
53	1	1.2 1.4	
54	2	1.2 5.1 5.2	
55	2	2.2 2.3	
56	2	1.2 1.4	
57	2	1.2 1.4	
58	1	2.1 2.6	
59	2	1.4 4.3	
60	2	1.2 1.4 4.3	
61	2	1.1 4.3	
62	2	1.2 1.4	
63	2	1.2 1.4 4.3	
64	2	2.4	
65	2	1.2 1.4 2.4	
66	2	1.2 1.4 4.6	
67	3	1.2 1.4 4.2 4.3 5.1	

Reading Grade 8

Table 5.2 Grade 8 Reading – Alignment and Depth of Knowledge By Item

Item	Cog Level	Standards	Notes
1	1	2.1 2.6	
2	2	1.4 2.4	
3	2	1.1 1.4	
4	2	2.4	
5	2	2.4 4.2	
6	2	1.1 1.4	
7	1	2.1 2.6	
8	2	1.1 1.4 2.3	
9	2	1.1 1.4	
10	2	1.1 1.4	
11	2	1.2 2.2	
12	2	1.2 1.1 1.4	
13	2	1.1 1.4	
14	1	2.1 2.6	
15	2	1.1 2.1 2.6	
16	2	1.2 1.4	
17	1	2.1 2.6	
18	2	2.2 2.3	
19	2	2.2 2.3	
20	2	2.2 2.3	
21	1	1.2 2.4	
22	3	2.2 1.1 1.4	
23	1	2.1 5.4	
24	2	1.2 1.4	
25	1	1.4 2.6	
26	2	1.2 1.4	
27	2	1.1 1.2 1.4	
28	1	1.4	
29	1	2.2 2.3	
30	1	2.1 2.6	
31	2	1.2 1.4	
32	2	1.2 1.4	
33	Field Test Item		
34	Field Test Item		
35	Field Test Item		
36	Field Test Item		
37	Field Test Item		
38	Field Test Item		
39	Field Test Item		
40	Field Test Item		
41	Field Test Item		
42	Field Test Item		
43	Field Test Item		
44	Field Test Item		
45	Field Test Item		
46	1	1.4 4.7	
47	1	4.7	

48	1	4.7	
49	2	1.2 1.4 4.7	
50	2	1.4 4.7 5.4	
51	1	2.1 2.6	
52	1	2.2 2.3	
53	2	2.4	
54	2	2.2 2.3	
55	1	1.2 1.4	
56	1	2.1 2.6	
57	3	5.3	
58	2	2.1 5.3	
59	1	1.2 1.4	
60	1	1.2 1.4	
61	1	2.1 2.6	
62	2	1.2 1.4	
63	2	2.4	
64	1	1.2 1.4	
65	1	4.2 4.3	
66	3	2.3 5.3 5.4	

Reading Grade 10

Table 5.3 Grade 10 Reading – Alignment and Depth of Knowledge By Item

Item	Cog Level	Standards	Notes
1	1	1.2	
2	2	2.3	
3	2	1.2 2.4	
4	2	1.2 2.4	
5	1	2.2 2.3 2.4	
6	1	1.2 2.6	
7	1	1.2 2.6	
8	1	1.2 2.6	
9	2	2.1 2.6	
10	2	1.2 1.1 2.6	
11	1	2.1 2.6	
12	2	2.2 2.3	
13	1	1.2	
14	1	2.1 2.6	
15	2	2.2 2.3 2.6	
16	2	1.2 2.6	
17	2	1.2 2.4	
18	1	1.2 1.4	
19	2	2.1 2.4 2.6	
20	2	1.2	
21	1	2.4 2.6 4.2	
22	3	1.4 2.3	
23	2	2.2	
24	2	1.2	
25	2	1.2 2.2	
26	2	1.2 2.2	
27	2	2.2 2.3	
28	2	1.1 1.2 2.2	
29	1	2.2 2.3 2.4	
30	2	1.1 1.4	
31	2	2.4 4.4	
32	2	2.4 4.4	
33	2	2.4 4.4	
34	2	1.2	
35	2	1.2	
36	2	1.2	
37	2	2.4	
38	Field Test Item		
39	Field Test Item		
40	Field Test Item		
41	Field Test Item		
42	Field Test Item		
43	Field Test Item		
44	Field Test Item		
45	Field Test Item		
46	Field Test Item		
47	Field Test Item		

48	Field Test Item		
49	Field Test Item		
50	Field Test Item		
51	2	2.3	
52	3	2.2	
53	2	2.2 2.4	
54	2	2.2 2.3	
55	2	2.2 2.3	
56	1	2.1 2.6	
57	2	2.4	
58	2	2.4	
59	2	2.4	
60	2	1.2 1.5 2.4	
61	1	1.2	
62	2	2.4	
63	2	2.4	
64	1	2.1 2.6	
65	2	1.2 2.4	
66	2	1.1 1.2	
67	2	2.4	
68	2	1.2 2.4	
69	2	1.2 2.4	
70	2	1.1 1.2 2.4	
71	2	4.3	
72	3	1.5 1.4 2.4	

Math Grade 4

Table 5.4 Grade 4 Mathematics – Alignment and Depth of Knowledge By Item

Item	Cog Level	Standards	Notes
1	1	5.2	
2	2	2.4	
3	2	4.3	Correct Answer Not Given
4	2	6.2	
5	2	5.2	
6	1	7.1	
7	2	6.2	
8	2	3.2 3.3	
9	1	4.3	
10	1	7.2	
11	1	7.1	
12	1	4.1	Misleading Diagram
13	1	2.2	
14	1	4.2	
15	1	5.1 5.3	
16	1	2.2	Weak correlation
17	1	4.1	
18	1	6.2 6.4	
19	1	2.4	
20	1	2.5	Weak Fit
21	2	7.1	
22	2	3.1 3.2	
23	1	2.1 2.5	
24	2	2.3 2.4	
25	2	6.2	
26	1	2.2	
27	1	3.1	
28	1	2.4 6.2	
29	1	2.1 2.4	
30	1	4.3	
31	Field Test Item		
32	Field Test Item		
33	Field Test Item		
34	Field Test Item		
35	1	6.4	
36			Aligns With NO Standards
37	2	6.4	
38	1	4.3	
39	2	5.1 5.3	
40	Field Test Item		
41	Field Test Item		
42	Field Test Item		
43	Field Test Item		
44	1	2.3	
45	2	5.1 5.3	

46	1	5.1 5.3	
47	2	1.2	
48	1	6.4	
49	X	X	
50	2	6.2	
51	1	7.1	
52	1	4.1	
53	1	5.1 5.3	
54	1	4.3	
55	1	3.2	
56	2	2.5	Fractions not in standards
57	2	6.2	
58			Aligns With NO Standards
59	1	7.1	
60	2	3.3	
61	1	5.1 5.3	
62	1	6.2	
63	1	4.3	
64	2	1.1	
65	1	2.3	
66	1	2.4	Weak Fit
67	1	2.3	
68	3	1.1 1.3	

Math Grade 8

Table 5.5 Grade 8 Mathematics – Alignment and Depth of Knowledge By Item

Item	Cog Level	Standards	Notes
1	2	7.1	
2	2	1.2 2.3	Error in Diagram
3	2	4.4	
4	2	5.4 5.5	Difficult Question
5	2	6.2 6.3	
6	1	2.1 2.2	
7	2	5.3 5.4	
8	2	1.1 1.3	
9	1	4.1	
10	1	6.2	
11	2	6.4	
12	2	4.2	
13	2	5.3	
14	2	7.3	Typo in question
15	2	5.3 5.4	
16	2	4.1	
17	2	5.4	
18	2	5.3 5.4	
19	2	2.3 4.2	
20	2	4.2 5.3	
21	1	5.5	
22	1	6.2 6.3	
23	2	3.4	
24	2	7.3	
25	3	3.4	
26	1	5.2 5.3	
27	1	2.2	
28	1	2.3 3.3	
29	1	3.2 7.2	
30	2	6.3	Difficult Question
31	Field Test Item		
32	Field Test Item		
33	Field Test Item		
34	Field Test Item		
35	1	2.2	
36	2	6.2	Choice B Poorly Worded
37	2	4.4	
38	1	4.1 4.2	
39	2	7.1	
40	Field Test Item		
41	Field Test Item		
42	Field Test Item		
43	Field Test Item		
44	1	7.2	Table should say “Total Savings”
45	1	2.3	Weak Fit

46	1	3.3	
47			Aligns With NO Standards
48	2	3.3	
49	1	3.2	
50	2	4.3	
51	1	2.3	
52	1	6.1	
53	1	3.1 3.2 7.5	
54	2	5.6	
55	2	2.3	
56	2	4.4	
57	1	3.2 3.5	
58	1	6.4	
59	2	2.4	
60	1	4.1 4.2	
61	1	2.3	
62	1	6.2	
63	2	6.3	
64	2	4.3 4.4	
65	1	2.3	
66	2	3.3 3.4	
67	2	2.2	
68	3	6.2	

Math Grade 10

Table 5.6 Grade 10 Mathematics – Alignment and Depth of Knowledge By Item

Item	Cog Level	Standards	Notes
1	1	2.1	
2	2	5.3	
3	1	6.2	
4	1	4.4	
5	1	4.5	
6	1	2.1	
7	1	6.2	
8			Aligns with NO Standards – does align with grade 8 6.2
9			Aligns with No Standards
10	2	5.4	
11	2	2.1	
12			Aligns with NO Standards
13	1	2.1	
14			Aligns with NO Standards
15	2	5.3	
16	2	6.4	
17	2	6.1	If graphing calculator is allowed
18	1	2.1	
19			Aligns With NO Standards
20	1	3.4	
21	2	7.1 7.4	
22	1	6.4	
23	1	4.2	
24	2	7.1	
25	2	4.2	
26	1	7.1	
27	2	3.3	
28	2	4.2	
29	1	5.1	
30	1	6.4	
31			Aligns With No Standards
32	2	5.3	
33	Field Test Item		
34	Field Test Item		
35	Field Test Item		
36	Field Test Item		
37	1	3.3	
38	1	4.2	
39	2	5.2	

40	1	3.2	
41	1	4.1	
42	1	2.1	
43	1	3.2	
44	1	3.2	
45	Field Test Item		
46	Field Test Item		
47	Field Test Item		
48	Field Test Item		
49	1	2.1	
50	1	2.1	
51	1	7.2	
52	1	6.1	
53	1	2.1	
54	1	5.4	
55	1	1.2	
56	1	3.5	
57	2	3.2	Bad question – what if a,b,c=0
58	1	4.1	
59	1	6.3	
60	1	4.3 7.2	
61			Aligns With NO Standards
62	1	2.1	
63	1	4.5	
64	1	4.2	
65			Aligns With NO Standards
66	1	7.1	
67	2	6.4	
68	1	7.1	
69	2	6.1	
70	1	2.1	
71	1	3.3	
72	1	2.1	
73	3	3.5 7.3	

Reference List

La Marca, P. M., Redfield, D., Winter, P. C., Bailey, A., & Hansche Despriet, L. (2000). *State Standards and State Assessment Systems: A Guide to Alignment.* Washington DC: Council of Chief State School Officers.

Peer Reviewer Guidance For Evaluating Evidence of Final Assessments Under Title I of the Elementary and Secondary Education Act. (1999). Washington DC, US Department of Education.

Standards and Assessments Peer Review Guidance: Information and Examples for Meeting Requirements of the No Child Left Behind Act of 2001. (2004). Washington DC, US Department of Education.

Webb, N. L. (1997). Determining alignment of expectations and assessments in mathematics and science education. National Institute for Science Education, Vol. 1, No. 2.

Webb, N. L. (April 1997). *Research Monograph No. 8: Criteria for alignment of expectations and assessment in mathematics and science education*. Washington DC: Council of Chief State School Officers.

Webb, N. L. (1999). *Research Monograph No. 18: Alignment of science and mathematics standards and assessments in four states*. Washington, DC: Council of Chief State School Officers.

Webb, N. L. (2002). *Alignment Analysis of State F Language Arts Standards and Assessments Grades 5, 8, and 11*. Washington DC: Council of Chief State School Officers.